Journal of Forestry Research (2013) 24(1): 69−74
DOI 10.1007/s11676-013-0326-0

ORIGINAL PAPER

Effect of physiographic factors on qualitative and quantitative characteristics of *Cornus mas* L. natural stands in Arasbaran forests, Iran

Ahmad Alijanpour

Received: 2012-03-06 Accepted: 2012-04-15

Abstract: Arasbaran forests are located in East Azerbaijan (northwest Iran). Increasing of socio-economic problems in this area causes destruction of biodiversity and structure of these forests. Using multipurpose trees such as cornelian cherry (*Cornus mas L*) to encourage villagers to produce forest by-products is a basic approach for preserving these forests. This species grows naturally in Arasbaran forests and the fruit is annually exploited using traditional harvest methods. This study aims to assess the ecological requirements of cornelian cherry and the important factors affecting its distribution. For this purpose, 40 circular sampling plots (300 m^2) on various slope aspects were demarcated for sampling the occurrence of cornelian cherry in forest stands. DBH and crown cover percentage on north aspects were significantly greater than on other aspects and 4.5% of all trees were cornelian cherry in mature forest stands. North aspects had more seed-origin trees (standards) of cornelian cherry than coppiced trees, while west facing aspects had more coppiced than standard trees. This species had the highest regeneration rate in the sapling stage of 0–2.5 cm DBH. Thus, I recommend cultivation and development of cornelian cherry as a multi-purpose tree in the Arasbaran region on degraded forest lands on north and west aspects.

Keywords: Arasbaran forests; aspect; physiographical factors; cornelian cherry (*Cornus mas* L.)

Introduction

Iran's forests cover over 14.2×10^6 ha and are divided into two general categories: northern forest (Hyrcanian) and northern outside forests (Keikhosravi & Kouchpideh 2007) which together cover about 8.6% of the nation's land area. Northern outside forests are not harvested for wood production, but play a valuable role in the national economy in terms of local livelihoods and environmental conservation, especially in soil and water resource conservation (Anonymous 2008). Arasbaran forests which are known as a northern outside forest are located in East Azerbaijan Province in northwest Iran. Diversity of microclimates and physiographic conditions result in a range of plant community types and rich biodiversity, making the site quite different from other forest zones throughout the country (Alijanpour 1996). Birang et al. (1993) reported 1,334 plant species of 493 genera and 97 families in the Arasbaran region. Degradation of these forests is caused mainly by inhabitants of the forest and adjacent villages. One strategy for conservation and renovation of Arasbaran forests is to encourage participation of these people in agroforestry and production of by-products from multi-purpose trees (Shamekhi 2006). One of these species is cornelian cherry which is considered an economically important species in Arasbaran forests. This species is propagated in Europe, Caucasus and Anatolia (excepting the north Mediterranean and Atlantic areas) (Mozafarian 2004). Villagers preserve cornelian cherry in natural stands to create fruit gardens (Sabeti 1994). The average annual fruit harvest is 914 kg per hectare in Kalaleh village in Arasbaran region (Ghanbary 2009). Cornelian cherry as a native species of the European continent that is resistant to biotic and abiotic factors. It grows best at elevations around 1,400 m. This species is able to grow at low temperatures (to -40 ºC) and its longevity is about 300 years (Brindza et al. 2007). Demir et al. (2003) mentioned cornelian cherry as a multipurpose species useful for production of fresh fruit that can be dried and preserved as jam or jelly. The bark and timber are also useful, and the leaves are a good source of tannin. Because of its high density wood, it has been used to produce some special tools and equipment. The mean weight of the fruit was about 2.8–3.85 g in Turkey in north Anatolia (karadeniz et al. 2009) and 2.11 to 6.71 g among 18 cornelian cherry genotypes in Vojvodina Province, Serbia (Bijelic´et al. 2011). Turkey has a long history of cultivating this species and there are 1.2 ×10^6 cornelian cherry trees in Turkey (Ercisli et al. 2008) where 12,800 tons

The online version is available at http:// link.springer.com

Ahmad Alijanpour (✉)
Faculty of Natural Resources, Urmia University, Pardis-e-Nazloo, Sero Rood, Zip code 5715944931, Urmia, I. R. Iran
E-mail: a.alijanpour@urmia.ac.ir; ahmad.alijanpour @yahoo.com

Corresponding editor: Zhu Hong

of fruit are harvested annually (Tural & Koca 2008). Each shrub produces between 2.8 and 4.8 kg of fruit annually. Cornelian cherries are very valuable for their medicinal and nutritional benefits and for production of raw materials for cosmetics. Vitamin C content in cornelian cherries is twice that of oranges (Klimenko 2004). In Serbia, Bijelic´et al. (2011) reported chemical composition of the fruit mesocarp including content of total dry matter (TSC), soluble solid content (SSC), total acids, total and reducing sugars, sucrose, Capectates, vitamin C, proteins, cellulose, anthocyanins, and tannins at 18%–33%, 17%–32%, 2%–4%, 12%–26%, 10%–24%, 0.4%–3%, 0.3%–2%, 15%–39 mg per 100 g fruit, 0.2%–3%, 0.4%–1%, 36–127 mg per 100-g fruit, and 0.6%–1.5%, respectively. Our research objective was to describe qualitative and quantitative characteristics of cornelian cherry in natural forest stands with respect to physiographic attributes such as aspect and slope.

Materials and methods

Study area

Arasbaran area comprises Ahar and Kaleybar cities. The study area is located in the Arasbaran forests, which consist of part of Garmnab, Harehsar, Armeni Olen, Ainalou and Vayeghan forest units. The total area is 708.6 ha. According to 15 years of statistic data of Kaleybar meteorology station, annual rainfall ranges from 289.5–521 mm with annual mean rainfall of 405.1 mm. Mean annual temperature is 17ºC at low elevations and 5 ºC in the high mountains. This area is related to the third period of geological age and the main rock types are calcareous and volcanic. The soil in forest areas is mainly brown and calcareous forest soil (Alijanpour 2001).

The main woody species in Arasbaran forests are Hornbeam (*Carpinus betulus*), Oak (*Quercus petrea*), Maple (*Acer campester*), Wild cherry (*Cerasus avium*), Yew (*Taxus baccata*), Ash (Fraxinus excelsior) and cornelian cherry (Marvie mohadjer 2005). Different forms of forests, including dense forest, semi-dense forest, shrubland and bushland are distinguishable in this area (Alijanpour 2001; Alijanpour et al. 2004).

Data collection

To evaluate quantitative and qualitative characteristics of cornelian cherry, we demarcated sampling plots in the forest stand at cardinal points where this species was most numerous within mature and regenerating stands. Considering the number, form and area of sample plots used in previous studies (Alijanpour et al. 2003) and estimated costs (Zobeiri 2005), authors sampled 40 circular plots, each of 300 m^2 area. The plots were set on four main slope aspects (10 sample plots in each main aspect). At each sample plot, the general specifications were noted. Then, the mature stand was assessed and all trees with >7.5 cm diameter at breast height (DBH) were measured and their origin and quality were recorded. For studying regeneration, they were divided into seedling, sapling and thicket initially and then individuals were counted. Thicket groups were classified into three groups: at DBH categories of 0–2.5 cm, 2.5–5 cm and 5–7.5 cm. In each plot, a soil sample from depth of 0–30 cm was collected and analyzed in Urmia University lab. In each plot I recorded tree/shrub species, percentage of crown cover, forest floor vegetation percentage, aspect and slope were coded and the data were prepared using Excel software. We used chi-squared test for comparing frequencies. ANOVA and Dunkan tests were applied to analyze and compare contiguous data. All statistical analyses were done using SPSS 15.

DCA (Detrended Correspondence Analysis) was applied to quantify relationships between distribution of species in the *Cornus mas* sites and environmental variables. Before data analysis, rare species were deleted from the species matrix. Cover data were transformed using ordinal transformation (van der Maarel 1979).

Aspect data were transformed using the equation A'=cos (45-A) +1 (Beers et al. 1966). The matrix of soil physical and chemical variables and physiographical features was standardized to mean 0 and variance 1 for each variable prior to ordination. The computer program PC-ORD for Windows version 3.0 (McCune and Mefford 2002) was used for this analysis.

Results

Mean DBH, crown coverage percentage, and seed-origin tree (standard tree) percentage on north aspects were significantly greater than on other aspects, while forest floor vegetation percentage was greater on south and east aspects (Table 1). There was no significant difference between percentages of healthy trees on different aspects (at 5% level), whereas there were significant differences in other cases (Table 1). Species mixture percentage is an important factor determining structure, type of forest stand and dominant species. Hornbeam (53.1%) and Wild cherry and wild apple (each 0.3%) were maximum and minimum of mature stand combination percentage, respectively (Fig. 1). Cornelian cherry accounted for about 4.5% of the trees in mature stands, so this species was not generally cultivated as the main and dominant species.

Table 1. Stand characteristics of cornelian cherry forest by cardinal point

Site aspect	Average of DBH (cm)	Percentage of crown coverage (%)	Percentage of forest floor vegetation (%)	Percentage of seed-origin tree (%)	Percentage of healthy (%)
North	14.92^{a}(0.43)	81.69^{a}(0.48)	9.68^{d}(0.85)	55.2^{a}	90.9
East	12.1^{c}(0.87)	68.19^{c}(1.65)	22.5^{a}(2.12)	26.7^{b}	100
South	13.17^{bc}(0.52)	56.25^{d}(1.68)	30.49^{a}(2.25)	14^{c}	100
West	13^{bc}(0.90)	74.42^{b}(0.82)	14.88^{c}(0.68)	43.2^{a}	91.9

Notes: Numbers in parenthesis are standard deviations. Different letters denote significant differences between aspects.

Diversity of woody plants on north and west aspects was greater than on south and east aspects, and cornelian cherry trees

with DBH >7.5 cm were recorded only on north and west aspects (Table 2).

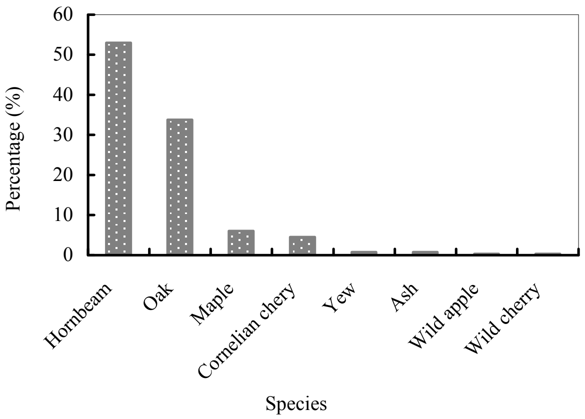

Fig. 1 Percent frequency of eight species in sampling plots

Hornbeam accounted for the highest percentage of trees in mature stands on north aspects. On east and west aspects, oak was most abundant. Cornelian cherry trees of DBH >7.5 cm were recorded only on north and west aspects and not on east and south aspects. There were significant differences between the frequencies of different species in each geographical aspect (at 5% level). Diversity of species on the north and west aspects of cornelian cherry sites was greater than on south and east aspects. Hornbeam, maple, ash, wild apple and wild cherry on slopes of 26%–50% gradient had the highest frequency. On slopes of 0–25%, oak had the highest frequency and on slopes of 51%–75%, cornelian cherry was most frequent. There were significant differences between the frequencies of species on the three slope gradient categories (Table 3).

Hornbeam, oak, and maple were the main species in all four geographical aspects (Table 4). Diversity of species on north aspects was greater than on other aspects. Mean DBH on north aspects of European Cornel habitat was also higher than on other aspects. On north aspects, hornbeam and maple had the largest DBH but on south aspects, maple had the largest DBH. There was no significant difference (at 5% level) between the DBH of species on east and west aspects (at 5% level). Cornelian cherry trees of DBH >7.5 cm were recorded on north and west aspects but on other aspects, DBH was less than 7.5 cm.

Table 2. Species mixture percentage on different aspects per plots

Aspect	Hornbeam	Oak	Maple	Cornelian cherry	Yew	Ash	Wild apple	Cherry wild	Total
North	75.3^{a}	11^{b}	5.8^{b}	4.5^{b}	1.3^{c}	1.3^{c}	0.6^{c}	0	100
East	13.3^{b}	76.7^{a}	10^{b}	0	0	0	0	0	100
South	29^{b}	65.2^{a}	5.8^{c}	0	0	0	0	0	100
West	37.8^{a}	35.1^{a}	8.1^{c}	16.2^{b}	0	0	0	2.7^{d}	100

Notes: Different letters at row denote significant differences between percentages of various species.

Table 3. Percentage of eight species on three slope gradient classes

Slope (%)	Hornbeam	Oak	Maple	Cornelian Cherry	Yew	Ash	Wild Apple	Wild Cherry	Total
0-25	25.7^{b}	62.9^{a}	5.7^{c}	5.7^{c}	0	0	0	0	100
26-50	57.9^{a}	29.2^{b}	7.9^{c}	2.8^{cd}	0	1.1^{d}	0.6^{d}	0.6^{d}	100
51-75	54.5^{a}	31.2^{b}	3.9^{c}	7.8^{c}	2.6^{c}	0	0	0	100

Table 4. Mean DBH and standard error of nine species on four slope aspects (cm)

Species	North		East		South		West	
	Mean of DBH	Standard error	Mean of DBH	Standard error	Mean of DBH	Standard error	Mean of DBH	Standard error
Hornbeam	15.93^{a}	0.493±	11.25	1.18±	11.85^{b}	0.786±	11.36	0.899±
Oak	12.35^{ab}	0.804±	11.78	1.03±	13.31^{b}	0. 684±	16.15	1.95±
Maple	14.67^{a}	2.205±	15.67	3.48±	18.22^{a}	0.629±	9.33	0.882±
Cornelian Cherry	8.57^{b}	0.297±	-	-	-	-	12.67	1.82±
Yew	9^{b}	1±	-	-	-	-	-	-
Ash	9^{b}	1±	-	-	-	-	-	-
Wild Apple	11^{ab}	0	-	-	-	-	-	-
Cherry	-	-	-	-	-	-	8	0
Total	14.9	0.43±	12.10	0.87±	13.17	0.52±	13	0.9±

The studied stands at cornelian cherry sites consisted of coppiced and standard trees. Percentages of coppiced trees on south aspects and standard trees on north aspects were most abundant. Maple, yew, wild apple and wild cherry grew as standard trees in sample plots, but all ash trees were coppiced. The percentage of cornelian cherry standard trees on north aspects was greater than

west aspects (Table 5).

All trees of DBH <7.5 cm were considered to result from natural regeneration. Maximum regeneration rate was recorded at thicket stage with trees of 0–2.5 cm DBH. Minimum regeneration was recorded at seedling stage. The average rate of regeneration in cornelian cherry sites was 117.1 per plot (3903.3 per hectare). There was a significant difference between regeneration frequencies between the four slope aspects (at 5% level), (Table 6).

Table 5. Seed-origin (standard tree) and coppiced tree percentage on four slope aspects (%)

Species	North		East		South		West	
	Standard	Coppice	Standard	Coppice	Standard	Coppice	Standard	Coppice
Hornbeam	51.7	48.3	25	75	5	95	14.3	85.7
Oak	52.9	47.1	30.4	69.6	11.1	88/9	61.5	37.5
Maple	100	0	100	0	100	0	100	0
Cornelian Cherry	57.1	42.9	-	-	-	-	33.3	66.7
Yew	100	0	-	-	-	-	-	-
Ash	0	100	-	-	-	-	-	-
Wild Apple	100	0	-	-	-	-	-	-
Cherry	-	-	-	-	-	-	100	0
Total	55.2	44.8	26.7	73.3	14.5	85.5	43.2	56.8

Table 6. Regeneration frequencies by growth stage on four slope aspects (individuals per plot)

Aspect	Seedling	Sapling	Thicket			Total	Average of regeneration per plot
			0-2.5 cm	2.5-5 cm	5-7.5 cm		
North	31[a]	54[b]	440[c]	316[a]	226[a]	1067[c]	106/7
East	33[a]	161[a]	543[b]	313[a]	146[b]	1196[b]	119.6
South	14[b]	160[a]	416[c]	150[b]	104[c]	844[d]	84.4
west	43[a]	183[a]	918[a]	324[a]	109[c]	1577[a]	157.7
Total	121	558	2317	1103	585	4684	117.1

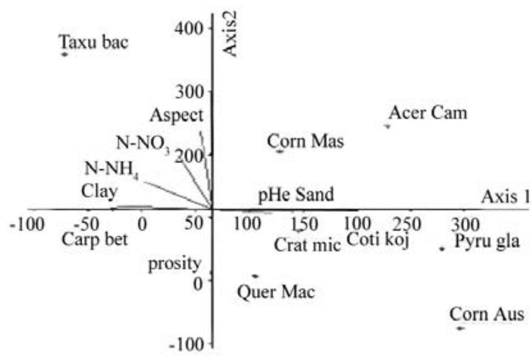

Fig. 2 DCA ordination of species of 40 sample plots

The species composition of the plots was evaluated by means of a DCA (Fig. 2). The first two DCA axes accounted for a total of 22.1% of the variance in species data. Axis 1 showed positive correlations with pH and sand and negative correlation with clay. I interpreted axis 1 as soil physical properties. DCA axis 2 showed significant positive correlations with slope aspect. Based on Beers's equation, slopes of northerly aspect had high correlation values as a result of greater moisture and lower temperatures. Southerly slope aspects showed lower correlation values. DCA axis 2 also showed positive correlation with mineral nitrogen so I interpreted DCA axis 2 as moisture and nitrogen gradient. In summary, cornelian cherry was mainly distributed on north slope aspects with high pH, high mineral nitrogen, and light soil texture.

Discussion

On northerly slope aspects, DBH, crown cover percentage and woody plant diversity were significantly greater than on other aspects. This can be related to growth conditions such as higher moisture and lower temperatures on northerly aspects as compared to southerly aspects (Small & McCarthey 2002). The low percentage of standard trees on southern aspects was due to inferior growth conditions and high intensity of anthropogenic disturbance (Table 1).

Over the entire study site, hornbeam and oak accounted for 86.9% of trees in mature stands, and were the two dominant species. Maple and cornelian cherry accounted for 11.1% in mature stands, and were secondary species. Since cornelian cherry is mostly found solely in the understory of open crown stands with a well-lighted forest floor (Fig. 1). This result is in accordance with previous studies conducted in both protected and unprotected areas of Arasbaran forests (Alijanpour et al. 2007).

Hornbeam, oak and wild cherry were planted at the highest frequency in mature stands (Alijanpour et al. 2007). Hornbeam, oak and maple on cornelian cherry sites had the highest fre-

quency (similar to previous studies), and cornelian cherry has been replaced by wild cherry. *Cornus florida* is primarily an understory species found in the eastern United States, from the southern tip of Maine to the northern half of Florida and as far west as Oklahoma and it is commonly associated with *Quercus* species and also occurs under *Pinus* stands (McLemore 1990).

The number of species on northern aspects was higher than on other aspects based on reasons mentioned above. In spite of the high percentage of crown cover and lack of suitable light condition, cornelian cherry was growing along the margin of roads, where suitable growth conditions were found.

On eastern and southern aspects, due to difficult habitat conditions, including warmer temperatures, reduced precipitation and humidity, cornelian cherry did not occur as a mature tree (>7.5 cm DBH). Where cornelian cherry was recorded on steeper slopes, the percentage of oak was lower and the percentage of hornbeam was higher. The highest percentage of cornelian cherry was observed at slopes of 51%–75%. This might be because of lower soil depths due to the increased slope gradient (unpublished data) (Table 3). *Cornus florida* often occurs on drier aspects such as the top of the slopes or on southern exposures (Haber 2007). But the mean DBH of cornelian cherry in the studied forest was 8.57 cm (northern aspects) to 12.67 cm (western aspects) (Table 4).

The reason for high DBH on westerly aspects could be related to high amount of light reaching the forest floor, which is conducive to growth of light demanding species. (Ferrell 1953, McLemore 1990). Most common as a small understory tree in the eastern United States, average height for *C. florida* ranges from 5−12 m and average stem diameter ranges from 3−8 cm (McLemore 1990).

The maximum frequency of cornelian cherry was observed in thickets with 0−2.5 cm DBH on all slope aspects, but at greater DBH on westerly aspects due to better sunlight and moisture conditions. In thickets with trees of 5−7.5 cm DBH, the reasons for reduced percent frequency of most species might be competition among individuals and tree harvest for use as fuel or construction material. Because of the specific characteristics of cornelian cherry wood, utilization of these species for construction and production of tools is popular in Turkey (Demir & Hakki 2003).

Riley and Jones (2003) reported that planting *Cornus florida* in clear cut areas causes significant increases in biomass, growth and leaf area in compare with pine-hardwood forest understory. Using a similar approach, cornelian cherry might be used in afforestation as a pioneer species in disturbed areas and/or abandoned farmlands.

Some studies illustrated that *Cornus florida* is a thin-barked species that is easily damaged by logging and fire, however, it will sprout prolifically from stumps when damaged (Kuddes-Fischer & Arthur 2002, Blankenship & Arthur 2006). Furthermore *Cornus florida* is common in many second growth forests, and is also common in old growth and undisturbed areas (Harrod et al. 1998; Jenkins & Parker 1998).

Qualitative and quantitative parameters of forest stands with cornelian cherry on west and north aspects showed better condition that did forests on east and south aspects. Thus, cultivation and development of cornelian cherry as a multi-purpose tree in degraded forest lands of the Arasbaran region on north and west aspects will have successful results. Afforestation in degraded forest lands using this species will have favorable environmental effects and will be beneficial in providing some economic value to villagers.

References

Alijanpour A, Zobeiri M, Marvi M, Zargham N. 2007. Comparison of qualitative characteristics of forest stands at both Arasbaran protected and non-protected areas. *Iranian Journal of Natural Resources*, **60**(1): 95−102.

Alijanpour A, Zobeiri M, Marvi M, Zargham N, Feghhi J. 2004. Comparison of quantitative characteristics of forest stands at both Arasbaran protected and non-protected areas. *Iranian Journal of Natural Resources*, **57**(3): 447−453.

Alijanpour A. 1996. Quantitative and qualitative survey on Arasbaran Forests: a case study in Sutanchai, MSc. Thesis. Tehran: Faculty of Natural resources, University of Tehran, p. 179.

Alijanpour A. 2001. Investigation and determination of optimum statistical methods and its application at Arasbaran forest. Ph.D thesis. Tehran: Faculty of Natural resources, University of Tehran, p. 160.

Alijanpour A, Zobeiri M, Marvi M, Zargham N. 2003. Study and determination of optimal statistic method in Arasbaran forests. *Iranian Journal of Natural Resources*, **56**(4): 397−405.

Anonymous. 2008. *Forests, Ranges & Watersheds Organization Activities of 9th Government*. Tehran: Forests, Ranges & Watersheds Organization (FRWO) publication, p. 64.

Bijelic SM, Golosin BR, Todorovic JIN, Cerovic SB, Popovic BM. 2011. Physicochemical Fruit Characteristics of Cornelian Cherry (*Cornus mas* L.) Genotypes from Serbia. *Hortscience*, **46**(6): 849−853.

Birang N, Javanshir A, Mojtahedi Y. 1993. *Azerbaijan Flora Collection Design*. Tabriz: Tabriz University, Faculty of Agriculture, p. 300.

Blankenship BA, Arthur MA. 2006. Stand structure over 9 years in burned and fire-excluded oak stands on the Cumberland Plateau, Kentucky. *Forest Ecology and Management*, **225**:134−145.

Brindza P, Brindza J, Toth D, Klimenko SV, Grigorieva O. 2007. Slovakian cornelian cherry (*Cornelian cherry* L.) potential for cultivation. *Acta Horticulture*, **760**: 433−438.

Demir F, Hakki KI. 2003. Some nutritional, pomological and physical properties of cornelian cherry (*Cornus mas* L.). *Journal of Food Engineering*, **60**: 335−341.

Ercisli S, Orhan E, Esitken A, Yildirim N, Agar G. 2008. Relationships among some cornelian cherry genotypes (*Cornus mas* L.) based on RAPD analysis. *Genetic Resources Crop Evolution*, **55**: 613−618.

Ferrell WK. 1953. Effect of environmental conditions on survival and growth of forest tree seedlings under field conditions in the Piedmont region of North Carolina. *Ecology*, **34**: 667−688.

Ghanbari S. 2009. The analysis of production, harvest, value and collectors of the non-wood forest products in Arasbaran region. MSc thesis. Tehran: NR faculty, University of Tehran, p. 98.

Haber E. 2007. Eastern flowering dogwood (*Cornus florida*) in Canada. COSEWIC assessment and status report, p. 22.

Harrod J, White PS, Harmon ME. 1998. Changes in xeric forests in western

Great Smoky Mountains National Park, 1936-1995. *Castanea*, **63**: 346–360.

Jenkins MA, Parker GR. 1998. Composition and diversity of woody vegetation in silvicultural openings of southern Indiana forests. *Forest Ecology and Management*, **109**: 57–74.

Karadeniz T, Deligoz H, Corumlu MS, Senyurt M, Bak T. 2009. Selection of native cornelian cherries grown in corum (Turkey). *Acta Horticulture*, **825**: 83–88.

Keikhosravi D, Kouchpideh N. 2007. Development history of Iranian natural resources. Tehran: Forests, Ranges & Watersheds Organization (FRWO) publication, p. 96.

Klimenko S. 2004. The cornelian cherry (*Cornus mas* L.): collection, preservation and utilization of genetic resources. *Journal of Fruit and Ornamental plant research*, **12**: 93–98.

Kuddes-Fischer LM, Arthur MA. 2002. Response of understory vegetation and tree regeneration to a single prescribed fire in oak-pine forests. *Natural Areas Journal*, **22**: 43–52.

Marvie mohadjer MR. 2005. *Silviculture*. Tehran: University of Tehran Press, p. 387.

McCune B, Mefford MJ. 2002. Analysis of ecological communities. Oregon, USA: MjM Software Design Press, p. 300.

McLemore BF. 1990. *Cornus florida* L. Flowering Dogwood. Silvics of North America, Vol. 2. Hardwoods. Agric. Handb. 654. U.S. Department of Agriculture, Forest Service: pp. 278–283.

Mozafarian V. 2004. *Trees and shrubs of Iran*. Tehran: Farhang-E-Moaser publication, p. 1003.

Riley JM, Jones RH. 2003. Factors limiting regeneration of *Quercus alba* and *Cornus florida* in formerly cultivated coastal plain sites, South Carolina. *Forest Ecology and Management*, **177**: 571–586.

Sabeti H., 1994. Forests, trees and shrubs of Iran. Yazd: University of Yazd Press, p. 810.

Shamekhi T. 2006. *Agroforestry*. Tehran: University of Tehran Press, p. 260.

Small CJ, McCarthy BC. 2002. Spatial and temporal variability of herbaceous vegetation in an eastern deciduous forest. *Plant Ecology*, **164**: 37–48.

Tural S, Koca I, 2008. Physico-chemical and antioxidant properties of cornelian cherry fruits (*Cornus mas* L.) grown in Turkey. *Scientia Horticulturae*, **116**: 362–366.

van der Maarel E. 1979. Transformation of cover-abundance values in phytosociology and it's effects on community similarity. *Vegetatio*, **39**: 97–114.

Zobeiri M, 2005. *Forest inventory*. Tehran: University of Tehran Press, p. 399.